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DILUTION OF CERAMIC SLIP USING COMPLEX ADDITIVES

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The effect of individual and complex liquefying additives containing S-3 superplasticizer on the rheological parameters of ceramic slip and its components is considered. A comparative analysis with industrially produced complex additive containing rheotan (imported deflocculant) is performed. The effect of the developed complex additives on the technological properties of slip for the production of sanitary ceramic ware is investigated.

One of the most topical challenges in producing ceramics by slip casting is to obtain slip with minimal moisture and sufficient mobility. For this purpose various thinning additives are used. The Construction Materials and Household Equipment Company (town of Staryi Oskol) uses rheotan, which is an expensive imported deflocculant, in combination with soda and water glass to increase the mobility of slips [1]. However, considering the high cost of imported additive, the development of a new effective and a less expensive complex additive is of interest.

We have investigated the effect of additives containing superplasticizing agent S-3, soda, water glass, and sodium tripolyphosphate (STPP) on the rheological and technological properties of ceramic slip and on its individual components: refractory clay from the Veselovskoe deposit (VRC), semiacid clay from the Veselovskoe deposit (VSC), and kaolin from the Glukhovetskoe deposit.

The effect of additives on the rheological properties of suspensions was estimated based on the variation in the shear stress τ_0 calculated based from rheological curves obtained with a Reotest-2 instrument. Soda, water glass, STPP, rheotan, and S-3 plasticizer were introduced in suspensions containing 56% (here and elsewhere weight content) dry material for VRC and VSC clays and 62% for kaolin. The additives were introduced individually or in the form of the following complexes: STPP + S-3 (in the ratio of 4 : 1, respectively), S-3 + water glass + soda, and rheotan + water glass + soda (ratio 3 : 6 : 2.5, respectively). The composition of the industrially applied additive was as follows (converted to dry material, wt.%): 0.030 rheotan (the imported reactant), 0.060 water glass, and 0.025 soda.

The results of the study are shown in Fig. 1. It can be seen that individual additives are less effective in diluting suspensions than complex additives. It is advisable to add STPP, which is widely used as a thinning agent in ceramic industry [2]. However, if it is introduced in combination with S-3 plasticizer, the thinning effect is much higher than if they are introduced separately. The S-3 + water glass + soda complex as well liquefies the specified system much more effectively than its individual components; furthermore, both specified complexes are more efficient that the “rheotan + water glass + soda” industrial complex additive.

In a similar way the effect of additives on the rheological properties of a ceramic slip with the following composition was investigated (%): 52 argillaceous materials, 32 grog component, 15 fluxes (Fig. 1*d*). It can be seen that the introduction of individual additives does not produce such thinning effect on ceramic slip and its components as the introduction of complex additives. Complex additives containing plasticizer S-3 are more effective that the industrially used additive, since the use of 0.15% industrial additive decreases τ_0 from 302 Pa to 0, whereas the same decrease in τ_0 is achieved by introducing S-3 + water glass + soda complex in the amount of 0.14% or by STPP + S-3 complex in the amount of 0.12%.

The effect of additives on the technological properties of slip was studied as well. An important technological parameter of slips is the mass accumulation rate V on the walls of gypsum molds. The mass accumulation rate was monitored using the known method of discharging slip from a gypsum cone in three steps after different time lapses. Furthermore, an Engler viscosimeter was used to determine the slip outflow time and the thickening coefficient K_t that was found as the ratio of the outflow time for 100 ml of slip after it was held undisturbed for 30 min τ_2 to the slip outflow time after holding it for 30 sec τ_1 [3]. The obtained results are listed in Table 1.

It can be seen that the introduction of complex additives containing plasticizer S-3 makes it possible to increase the

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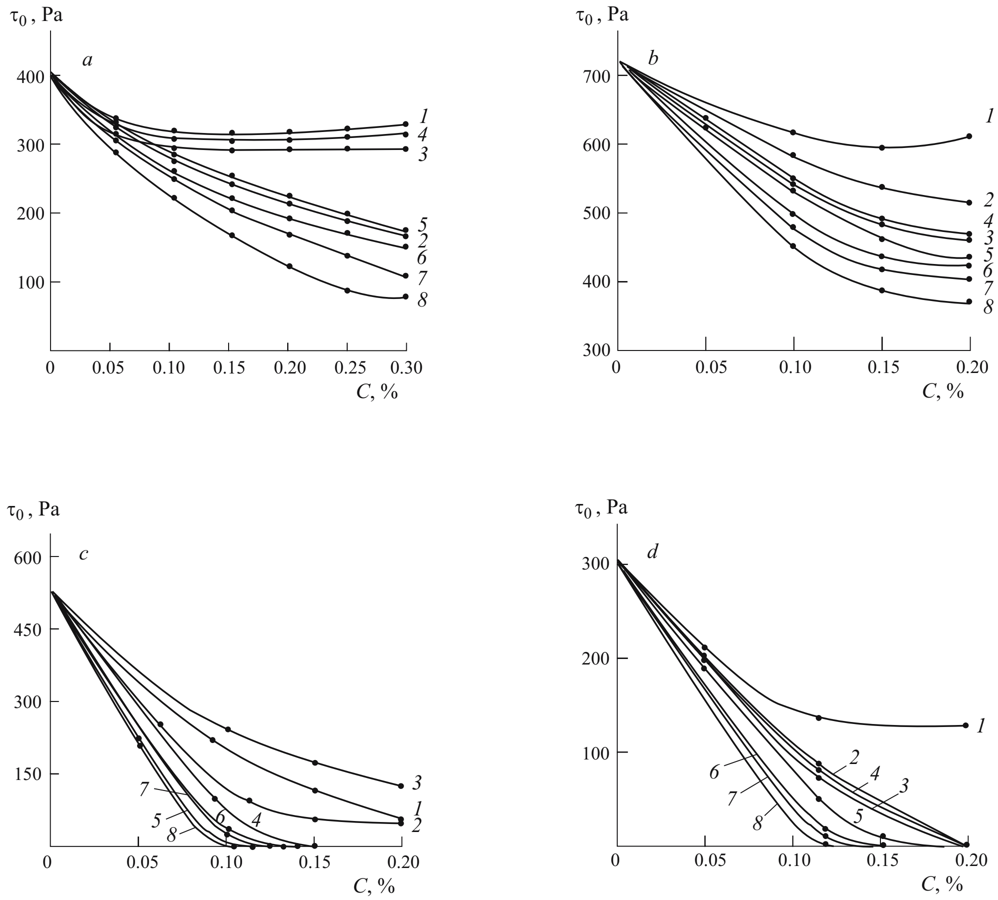

Fig. 1. Dependence of shear stress τ_0 on the content C of additives in suspensions of clays VRC (*a*) and VSC (*b*), kaolin (*c*), and in ceramic slip (*d*): *1*) water glass; *2*) soda; *3*) plasticizer S-3; *4*) rheotan; *5*) STPP; *6*) rheotan + water glass + soda; *7*) S-3 + water glass + soda; *8*) S-3 + STPP.

TABLE 1

Additive	τ_1, sec	τ_2, sec	K_t	V, g/cm^2
0.03% rheotan + 0.06% water glass + 0.025% soda	15	25	1.7	0.056
0.03% S-3 + 0.06% water glass + 0.025% soda	13	20	1.5	0.062
0.02% S-3 + 0.08% STPP	14	17	1.2	0.058
0.10% STPP	16	21	1.3	0.053

slip mobility and lower the thickening coefficient. It should be noted that the introduction of STPP in combination with plasticizer S-3 increases slip mobility more than STPP by itself. This can probably be attributed to synergism, i.e., the effect of single components being intensified by joint introduction. When STPP is introduced as an individual liquefying additive, the mass accumulation rate is lower than introducing the industrial additive. However, when STPP is introduced together with plasticizer S-3, the mass accumulation rate is 4% higher compared to the industrial additive. The introduction of plasticizer S-3 combined with soda and water glass makes it possible to increase the mass accumulation rate by 19%, which has a favorable effect on the process of producing ceramic articles.

Thus, the use of complex additives containing superplasticizer S-3 improves the mobility of ceramic slip and its seeping properties. Furthermore, replacement of the expensive imported component by a less expensive domestic superplasticizer makes it possible to lower the production cost of the finished product.

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